

## **Quadrant II - Transcript and Related Materials**

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### **Notes**

#### **Introduction**

The Earth's lithosphere is composed of varieties of rocks and their related relief features. Relief features are distinct landforms depicting the nature parent rocks and the geological process that have created them. Landforms, their origin, their dynamism and distribution are studied in earth's physical sciences under the branch of geomorphology. The relief of any land is not permanent on the earth's surface.

Every block of rock is subjected to aerial actions and modifications. Over a period of geological times, these surface blocks and rocks break down into smaller and finer pieces and move away from their sources. Since the rocks present in the uppermost layers of the earth's crust are in close interaction with

the processes of atmosphere, hydrosphere and biosphere, they are dynamic features.

## **Geomorphic processes**

The Sun's radiant energy, role of water of the hydrological cycle, role of oxygen and carbon-di-oxide of the atmosphere and the action of organic acids over the rock masses, play a significant role in the material transformation over the surface of the earth. All the rocks exposed at or near the surface of the earth are subjected to various physical and chemical processes. These rocks are mostly unstable and are attacked by aerial agencies both physically and chemically. The processes acting on the surface are called as geomorphic processes.

## **Weathering**

Weathering is an important geological mechanism which can destabilize the earth's surface materials and remove them by erosive processes. Weathering is the physical disintegration and chemical decomposition of a rock mass on the land. It is a unique phenomenon happening on the earth's surface.

Weathering is a collective term used to denote the mechanical, chemical and biological(organic) processes that take place on the earth's surface. Weathering of rock-forming minerals can create new products from pre-existing rocks.

In many regions, soils are the ultimate products of weathering. Weathering of rocks releases chemical compounds that become available for biological processes. It is necessary to study the factors that are influencing the weathering processes.

### **Factors influencing**

Weathering is defined as the natural breakdown of rocks into minor fragments, soils and sediments. There are many factors which influence the weathering of minerals and rocks. They are:

1. Topography
2. Climatic conditions – temperature and humidity
3. Physical characteristics of rocks
4. Chemical and structural characteristics of rocks- their mineralogy and structural features.
5. Vegetation- their abundance and type, including the micro and macro vegetation. Weathering involves no moving agent of transport.

### **Types of weathering**

Weathering is a general term for several processes. In general, weathering is of three types as :

- a) Physical weathering
- b) Chemical weathering and
- c) Biological weathering.

The chemical and physical weathering often go hand in hand. Physical weathering can occur due to temperature, pressure, frost, etc. Living organisms may contribute to mechanical weathering, as well as chemical weathering. Lichens and mosses that are growing on bare rock surfaces may create a more humid chemical microenvironment. The attachment of these organisms to the rock surface enhances the physical as well as chemical breakdown of the surface layer of the rocks. These are all very slow and silent processes.

### **Physical weathering**

Physical weathering is also called as mechanical weathering. Mechanical weathering is related to the physical breakup of rocks into small pieces and fragments. In physical weathering, there is no change in the chemistry of the parent rock. The physical characteristics of rocks also influence the process of physical weathering.

The characteristics are differential composition , particle size , the hardness and degree of cementation. Some rock bodies are very resistant due to their strong physical properties. They may not be attacked by physical weathering processes. The structure of rocks are fully favorable to weathering activities. Presence of joints in rock bodies are typical examples.

## **Chemical weathering**

Chemical and structural characteristics of minerals present in rocks are also expected to play a significant role in weathering. Chemical weathering changes the composition of rocks, often transforming them when water interacts with their minerals to create various chemical reactions. Chemical weathering is a gradual and ongoing process as the mineralogy of the rock adjusts to the near surface environment.

For minerals of given particle size, chemical and crystalline characteristics determine the ease of decomposition. (e.g.) gypsum – sparingly soluble in water, is dissolved and removed in solution form under high rainfall. Ferro magnesium minerals are more susceptible to chemical weathering than feldspar and quartz.

Tightness of packing of ions in crystals is yet another property for encouraging mineral weathering processes. Less tightly packed minerals like olivine and biotite are easily weathered as compared to tightly packed zircon and muscovite (resistant).

## **Physical weathering processes**

Physical weathering happens especially in places where there is little soil and few plants grow, such as in mountain regions and hot deserts. The types of physical weathering include; abrasion, crystallization, root wedging, insolation weathering, human mining, animal activity, tumbling, compressional stress, crushing

waves, tensional stress. Physical weathering is more effective in areas which have a little vegetation, a large diurnal range of temperature or, temperatures fluctuating around 0 degrees Celsius.

## **Abrasion**

The primary process of physical weathering is abrasion. It is the process in which rock blocks are reduced in their sizes. Sand and other particles normally move above rock bodies. The mechanical scraping of a rock surface by friction between rocks and these moving particles is known as abrasion. Particles are transported by wind, glacier, waves, gravity, running water or erosion. After friction, the moving particles dislodge the loose and weak debris from the sides of the rock. These particles can be dissolved in the water and taken away to some other location.

Abrasion by water, ice, and wind processes loaded with sediment can have tremendous cutting power. The intensity of abrasion depends on the hardness, concentration, velocity and mass of the moving particles. The major incidences responsible for physical weathering are expansion resulting from unloading, crystal growth, thermal expansion, organic activity and colloidal plucking.

## **Mechanisms of Physical weathering**

The major mechanisms of physical weathering include:

- a) Freezing and thawing
- b) Root wedging and
- c) Heat Spalling.

Recurring hotness and coldness is an important controlling factor in weathering. One of the main causes of physical weathering is the formation of ice in cracks or cavities within rocks.

### **Freezing and thawing**

Block disintegration occurs when rocks split along joints. This can happen as a result of repeated cycles of freezing and thawing. Freezing and thawing are the first set of processes. First, water soaks into the cracks or cavities, of the rocks existing below the surface and get sealed up. Then, if the temperature falls low enough during night times, the water freezes. When water freezes into ice, its volume gets increased by nine percent. As a result of this, it expands (thaws) in the cracks and may push hard enough to split the rock into minor fragments. Under specific circumstances, this expansion is able to displace and create fractures in most of the rocks. Not all volumetric expansion is caused by the pressure of the freezing water; it can be caused by stresses in water that remains unfrozen.

### **Frost weathering**

Frost weathering is a collective name given for several mechanical weathering processes induced by stresses created

by the freezing of water into ice. The term includes a variety of processes such as frost shattering, frost wedging and cryofracturing. The process may act on a wide range of spatial and temporal scales, from minutes to years and from dislodging mineral grains to fracturing boulders. Frost weathering is mainly driven by the frequency and intensity of freeze-thaw cycles and the properties of the materials subject to weathering. It is most pronounced in high altitude and latitude areas.

### **Root Wedging:**

The second mechanism is the root wedging. Plant root, have a great role to play in weathering. Plants are effective agents of mechanical weathering. Roots can penetrate through the cracks of rocks to depths of several meters. As the roots grow, they exert a tremendous amount of pressure on the walls of the cracks. This breaks them into pieces. Root wedging is a major process of mountains containing Forests and natural vegetation.

### **II. Chemical Weathering:**

It changes the basic properties of the rock. Principal processes of chemical weathering are:

(a) Solution: Here the rocks are completely dissolved. This process involves removal of solids in solution and depends upon solubility of a mineral in water or weak acids. On coming in contact with water many solids disintegrate and mix up as suspension in water.



Soluble rock forming minerals like nitrates, sulphates and potassium etc. are affected by this process. So, these minerals are easily leached out without leaving any residue in rainy climates and accumulate in dry regions. Minerals like calcium carbonate and calcium magnesium bicarbonate present in limestones are soluble in water containing carbonic acid (formed with the addition of carbon dioxide in water), and are carried away in water as solution. Carbon dioxide produced by decaying organic matter along with soil water greatly aids in this reaction. Common salt (sodium chloride) is also a rock forming mineral and is susceptible to this process of solution.

### **(b) Oxidation and Reduction:**

In weathering, oxidation means a combination of a mineral with oxygen to form oxides or hydroxides. Oxidation occurs where there is ready access to the atmosphere and oxygenated waters. The minerals most commonly involved in this process are iron, manganese, Sulphur, etc. Though it is a universal phenomenon but it is more apparent in rocks containing iron. In the process of oxidation rock breakdown occurs due to the disturbance caused by addition of oxygen. Red color of iron upon oxidation turns to brown or yellow. When oxidized minerals are placed in an environment where oxygen is absent, reduction takes place. Such conditions exist usually below the water table, in areas of stagnant water and waterlogged ground. Red color of iron upon reduction turns to greenish or bluish grey.

### **(c) Hydration:**

Hydration is the chemical addition of water. Most of the rock-forming minerals absorb water. Minerals take up water and expand. This not only increases their volume but also produces chemical changes resulting in the formation of new minerals which are softer and more voluminous. e.g. this process converts hematite into limonite. Calcium sulphate takes in, water and turns to gypsum, which is more unstable than calcium sulphate. This process is reversible and long, continued repetition of this process causes fatigue in the rocks and may lead to their disintegration. Many clay minerals swell and contract during wetting and drying and a repetition of this process results in cracking of overlying materials. Salts in pore spaces undergo rapid and repeated hydration and help in rock fracturing. The volume changes in minerals due to hydration will also help in physical weathering through exfoliation and granular disintegration.

### **(d) Carbonation:**

Carbonation is the reaction of carbonate and bicarbonate with minerals and is a common process helping the breaking down of feldspars and carbonate minerals. Carbon dioxide from the atmosphere and soil air is absorbed by water, to form carbonic acid that acts as ,a weak acid. Calcium carbonates and magnesium carbonates are dissolved in carbonic acid and are

removed in a solution without leaving any residue resulting in cave formation.

### **III. Biological Weathering:**

This type of weathering is performed by the tree roots, animals and human beings. As the plant roots grow, they wedge the rocks apart and cause the widening of joints and other fractures. Micro animals like earthworms, ants, termites and other burrowing animals move materials to or near the surface where they are more closely subjected to chemical weathering.